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PREVENTING THE DISTRIBUTION OF PINE TIP MOTHS ON
NURSERY STOCK

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Insect Investigations

There is evidence that pine tip moths are frequently introduced into isolated pine plantations on infested nursery stock. The stage in which the insects are transported depends on the life cycle of the different species, those emerging in early spring being commonly carried in the egg stage. Once the moths become established, it is practically impossible to eradicate them, and any measures used to prevent their introduction would be justified.

Experiments with the midwestern pine tip moth (Rhyacionia frustrana bushnelli Busck) in Nebraska have demonstrated the effectiveness of two dips in destroying the eggs on nursery stock in early spring. These insecticides should prove effective also against the eggs of the Nantucket pine tip moth (R. frustrana Comst.), which is scarcely distinguishable from the above variety. This species occurs throughout the Eastern, Central, and Southern States, while the midwestern pine tip moth occurs in Nebraska, the Dakotas, Minnesota, and probably Wisconsin. Depending on latitude and altitude, from one to four generations are produced annually; one in Minnesota and the Black Hills of South Dakota, two in Nebraska, two in the vicinity of Washington, D. C., and four in Louisiana. In all localities the first moths begin emerging in the spring about the time tree activity starts, and egg laying continues over a period of several weeks. The eggs will, therefore, be carried on spring-dug stock, and dipping is recommended for the prevention of distribution in this stage. Prevention of distribution in the pupal stage is discussed later.

Prevention of Distribution in the Egg Stage

Stock to be Treated

All the two- and three-needle or hard pines are subject to attack (with the possible exception of longleaf pine, which has not yet been found infested). Consequently all susceptible pines, in nurseries infested with these tip moths, in nurseries adjacent to timber which would be a source of infestation, or field collected, should be dipped before shipment in early spring. This applies to stock that is to be utilized in isolated plantations or areas where the moths do not occur.

There is no object in treating stock to be planted in areas already infested or in or adjacent to natural timber where these insects are present.

Dipping Materials

White oil emulsion: This material is by far the cheapest of the two herein recommended, and has a wider range of effectiveness. The dip is prepared by mixing the emulsion directly with water at the rate of 1 part by volume of white oil emulsion to 100 parts of water. The emulsion comes in the form of a thin paste and should be thoroughly stirred or shaken with a small quantity of the water before being added to the full tank, to facilitate a complete mixture. It is very important to have the oil evenly distributed in the mixture. (The emulsion tested contained 83 percent petroleum oil, the actual concentration in the mixture, therefore, being slightly less than 1 percent. If white oil emulsions containing less than this concentration are used, it would be advisable to bring the oil content up to about 1 percent; however, none of these have yet been tested for their effectiveness.)

The continued dipping of trees and the accumulation of soil and litter in the bath gradually decreases the oil content, necessitating the mixing of fresh material at intervals. An average of 1,000 seedlings or transplants for each gallon can be dipped before the mixture needs changing; thus 10 gallons would treat 10,000 trees. The quantity needed on a project can be estimated on the basis that 1 gallon of white oil emulsion will make 100 gallons of dip and will treat 100,000 trees.

This mixture has been used on 2-0* ponderosa pine without injury after elongation of the shoots had started. Although dipping the roots caused little or no injury, only the tops need to be treated. On nearly dormant seedlings three times the above concentration caused no damage. A 2-percent mixture has been sprayed on ponderosa pine in midsummer without injury (incidentally, three applications during the summer egg-laying period of the moth in Nebraska, applied at 6-day intervals corresponding to the incubation period, gave a marked reduction in the amount of tip moth injury on the sprayed trees, and this method might be used to advantage in limited plantations).

Nicotine oleate: This material, used at the rate of 1 part of nicotine to 200 parts of dipping mixture, gave a consistent kill of the eggs and caused no injury to nearly dormant transplants of ponderosa, jack, and Scotch pines. A stock emulsion is prepared by thoroughly mixing a nicotine solution which contains 40 percent of volatile or "free" nicotine with commercial oleic acid, forming a soft soap. These materials are mixed in the following proportions: 10 parts by volume of the 40-percent nicotine to 7 parts of oleic acid. For the dipping mixture, dilute 1 part of the stock emulsion with 46 parts of water. Thoroughly shake or stir the stock emulsion with a small quantity of the water before mixing into the full tank.

* In seed bed 2 years; not transplanted.

With continued dipping this material loses its insecticidal value more rapidly than the white oil emulsion. Not over 500 seedlings or transplants for each gallon should be treated. At the above rates, 1 gallon of 40-percent nicotine plus 0.7 gallon of oleic acid would make approximately 80 gallons of dipping mixture and treat 40,000 trees.

Other material tested: Lubricating oil emulsion, diluted to give a 10-percent oil concentration, was effective on the eggs, but in one test it seriously injured the seedlings because the oil separated out. It is unsafe to use unless a satisfactory emulsion can be made and maintained. A miscible oil might provide a more stable emulsion. Dormant-strength lubricating-oil mixtures, if applied after the new shoots have started to elongate, are likely to injure many of the tips, while the more refined white oils can be used at very low concentrations with comparative safety.

Dipping Procedure

Always stir the mixture thoroughly before dipping, particularly where the treating is not continuous. The trees can be handled in loose bundles of a hundred or more, if the tops are not compact. Douse the tops up and down in the solution for 15 or 20 seconds to insure the wetting of all surfaces; all needles should be immersed, since many of the eggs will occur on them. It is not necessary and perhaps not advisable to dip the roots. After dipping, place the trees on a drain board for several minutes, permitting the excess liquid to drain back into the tank. The trees can then be packed.

A large wash boiler or similar container, deep enough to prevent forcing and breaking the buds against the bottom, is usually convenient for dipping the stock. A more shallow vessel should not be used. A larger tank might prove more suitable where very large quantities of trees are to be handled within the period of several days. It is not advisable to prepare large quantities of the dip for use over a long period, especially with the nicotine oleate. The smaller containers, necessitating the mixing of fresh dip at least after 2 or 3 days, would give the best results.

Prevention of Distribution in Other Stages

The Nantucket pine tip moth passes the winter as a pupa in the infested tips. This species, therefore, is likely to be transported in the pupal stage on both fall- and spring-dug stock, as well as in the egg stage during early spring. The dips recommended for the eggs would probably have little or no effect on the pupae in the burrows, and consequently with pupae present it will be necessary to remove all infested tips from stock to be shipped to uninfested areas. In early spring both dipping and the removal of tips will have to be resorted to if only a portion of the moths have emerged at the time of digging. The infested tips can usually be distinguished by dead needles at the apex, or by the pitchy webs, resembling unnatural pitch exudations, around the base of the buds. The tips should be cut off an inch or more below the injured part, since occasionally cocoons are spun outside the burrows on the shoot.

The midwestern pine tip moth, however, winters in cocoons in the litter and soil, as a pupa. Consequently the egg is the only stage likely to be carried on nursery stock in early spring. To prevent the possibility of transporting pupae in the soil, the use of nursery soil in packing the trees should be avoided.

Nature of Tip Moth Injury

The eggs are deposited mostly on the needles, although some may also be placed on bud scales or new shoots. Damage is caused by the larvae feeding in the buds and new growth shoots. A single larva may hollow out only the buds, but when many larvae are present a large portion of the new shoot may be riddled, the work progressing downward from the apex. Trees are susceptible to serious injury until a height of 20 to 30 feet is attained. Although trees are seldom killed, except on very poor sites, repeated heavy infestation causes a bushy, deformed crown and greatly retards height growth. Isolated plantations are apt to suffer more continuous damage than stands of natural reproduction, because of the lack of natural control factors. Nursery stock is usually lightly attacked, frequently only a small percentage of the tips being infested.

Other Tip Moths

European pine shoot moth (*Rhyacionia buoliana* Schiff.): This introduced species is prevalent in parts of the New England States and has been reported in certain localities in States both south and west of this region. The moths emerge and lay eggs early in the summer, thus the spring dipping of nursery stock would not apply to this species. The winter is passed as a partly grown larva in the bud, and all infested buds would have to be removed to prevent distribution to new areas.

Southwestern pine tip moth (*Rhyacionia neomexicana* Dyar): This moth occurs in the Southwest, eastern Colorado and Wyoming, Nebraska, and the Black Hills of South Dakota. It winters in the pupal stage in cocoons spun in bark crevices on the base of the infested trees. A single generation occurs annually, the moths flying and laying eggs early in the spring. Recent preliminary experiments have shown that a dip containing 1 percent of white oil emulsion is not entirely effective in destroying the eggs of this species, the young eggs being killed but some of the old eggs hatching. Therefore, until further experimentation, it is recommended that a mixture containing 2 percent of the white oil emulsion be used for the spring dipping of infested nursery stock within the range of this moth. Two applications of the 2-percent mixture as a spray in the field during the egg-laying period has given a good reduction in the amount of infestation on the treated trees.